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Chapter 14. Drinking Water Treatment and Distribution

Providing a reliable supply of safe drinking water is the primary goal of public water systems in California. To achieve this goal, public water systems must develop and maintain adequate water treatment and distribution facilities. In addition, the reliability, quality, and safety of the raw water supply are critical to achieving this goal. In general, public water systems depend greatly on the work of other entities to help protect and maintain the quality of the raw water supply. Many agencies and organizations have a role in the protection of water supplies. For example, the basin plans developed by the Regional Water Quality Control Boards (Regional Boards) recognize the importance of this goal and emphasize the protection of water supplies in California—both groundwater and surface water.

A public water system is defined as a system for the provision of water for human consumption, through pipes or other constructed conveyances, which has 15 or more service connections or regularly serves at least 25 individuals daily at least 60 days of the year (Health & Saf. Code, § 116275(h).).

Public Water Systems (PWS) are divided into three principle classification: community water systems (CWS), non-transient no-community water systems (NTNC), and transient non-community water systems (TNC). As the name indicates, CWS serve cities, towns and other residential facilities used by year-round users – examples include everything from apartment complexes served by their own well, to systems serving our largest cities. NTNC systems are PWS systems that are not CWS and that provide water to the same non-residential users daily for at least 180-days out of the year – examples include schools, places of employment, institutions, etc. TNC are places that provide water for a population that mostly comes and goes – examples include: campgrounds, parks, ski resorts, rest-stops, gas stations, motels, etc. Table 14-1 shows the number of public water systems in California by class. Community Water Systems serve approximately 36.6 million of the estimated 37.7 million people throughout the state, or 97 percent of the state's population. The remaining estimated 1.1 million people in the state (3 percent of the population) receive their drinking water from private wells serving their individual residences, or from other sources. Virtually every Californian, and visitor to our state, will drink water from a regulated PWS, either through their work, while on vacation, or while traveling through the state. Figure 14-1 shows water system by class and size in California.

PLACEHOLDER Table 14-1 Public Water Systems in California by Class

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of the chapter.]

PLACEHOLDER Figure 14-1 Public Water System Class by Size and Percentage

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of the chapter.]

Under the California Safe Drinking Water Act (SDWA), the California Department of Public Health or CDPH Drinking Water Program has adopted regulations to ensure high quality drinking water is provided by public water systems at all times. In developing drinking water regulations and carrying out the public water system regulatory program, CDPH recognizes that healthy individuals and communities cannot exist without safe, reliable water supplies. This is a necessity for not only for drinking water, but also to meet basic sanitary and public safety needs.

Drinking water regulations mandated by the California SDWA apply to all public water systems, regardless of their type of ownership. There are two basic ownership types that can be identified; publicly owned and privately owned water systems. Publicly owned systems include municipalities, special districts, and federal or state government systems. Privately owned systems include investor-owned utilities, mutual water companies, mobile home parks, and water associations, and may also include various commercial enterprises such as restaurants, hotels, resorts, employee housing, etc., that have their own water supply. While CDPH regulates all public water systems for all aspects that may affect water quality regardless of the type of ownership, the California Public Utilities Commission (CPUC) regulates privately owned, for-profit systems serving communities for the purposes of establishing appropriate water rates. The CPUC regulates sole proprietorships, partnerships and corporations that provide water service to the public for profit. Mutually owned systems and homeowners associations are exempt from CPUC oversight if they provide water only to their stockholders or members. In addition, systems serving privately owned Mobile Home Parks are also exempt; except that CPUC may conduct an investigation into water rate abuses when they receive complaints from residents. Table 14-2 provides a summary of the number and size of the CPUC-regulated water systems.

PLACEHOLDER Table 14-2 Number and Type of CPUC-Regulated Water Agencies

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of the chapter.]

At the federal level, the US Environmental Protection Agency (USEPA) has the responsibility to ensure the implementation of the federal SDWA and related regulations. The State of California has primacy for the public water system regulatory program in California and works closely with USEPA in carrying out the program. In addition, local primacy agencies (typically the county environmental health departments) have the responsibility for the regulation of many small public water systems (typically those serving less than 200 homes) in 31 of the 58 California counties. USEPA directly provides regulatory oversight over Tribal water systems.

Public water systems rely on groundwater, surface water or a combination of both as their source of supply. Groundwater wells used for drinking water are constructed in a manner to intercept high quality groundwater and therefore many groundwater wells require little to no treatment. However, some groundwater wells are impacted by manmade and/or naturally occurring contaminants that require treatment to achieve the high level of quality mandated by State and federal regulations for a safe, reliable supply of water. All surface water supplies used for drinking water must receive a high level of treatment to remove pathogens, sediment and other contaminants before they are suitable for consumption. Once the water is treated to drinking water standards, this high level of water quality must be maintained as the water passes through the distribution system to customer taps. Water treatment and distribution issues are discussed in detail in this resource management strategy. An increasing effort is aimed at preventing pollution and matching water quality to water use. This work is described elsewhere in this volume under the resource management strategies Pollution Prevention and Matching Water Quality to Water Use.

The use of bottled water in the United States has been an increasing trend, however recently that trend has flattened from 2007 through 2011. The Beverage Marketing Corporation and International Bottled Water Association report that US consumption of bottled water was 29.2 gallons per person in 2011 and 29.0 gallons per capita in 2007. In 2005, California ranked No 1 in the nation for percent of the bottled water share (23.9 percent) and was ranked No. 3 behind Arizona and Louisiana for per capita consumption at 51.2 gallons (Donoho, 2007). Some of the reasons that individuals choose to use bottled water include convenience, image, taste, and perceived health benefits. On the other hand, many consumers are becoming aware of the environmental impact associated with the production, transportation and waste disposal of bottled water including the contributions to green house gas emissions. While tap water and bottled water are regulated differently, both are generally safe, healthy choices. Tap water (as provided by a public water system) provides public health and fire protection among its other advantages to a modern quality of life. Bottled water costs significantly more than tap water for the volume consumed in cooking and drinking.

Bottled water is regulated by the US Food and Drug Administration under the 1938 Food, Drug and Cosmetic Act (FD&C Act). California regulates bottled and vended water to a much greater degree than provided in the FD&C Act. California's Sherman Food, Drug and Cosmetic Law is the basic statute that authorizes such regulation and is implemented by the CDPH Food and Drug Branch.

Drinking Water Treatment in California

Public Health

Water treatment includes processes that treat, blend, or condition the water supply of a public water system for the purpose of meeting primary and secondary drinking water standards. These processes include a wide range of facilities, such as: in surface water sources, basic chlorine disinfection, filtration, and, more recent, technical advances—membrane filtration, ultraviolet light, and ozone to meet pathogen removal and/or inactivation as well as disinfection requirements (while controlling disinfectant byproducts); in groundwater sources, chemical removal and blending facilities; or buffering to ensure the water is not corrosive in the distribution system and customers' piping. Blending treatment, a process of reducing the concentration of a contaminant in one water source by blending or dilution with water that has a lower concentration of contaminants, is an acceptable practice for meeting chemical water quality standards. Fluoridation treatment, now commonly practiced in California, may be used to add fluoride to an optimal level that provides dental health benefits.

Widespread treatment of drinking water, especially disinfection, filtration and fluoridation, was a great public health advancement of the 20th century. The 21st century promises to bring additional advances in water treatment technologies to improve the removal of contaminants, reduce cost, improve water use efficiency (increase water recovery and reduce waste streams) and manage energy consumption. Water recovery, or recycling, is the water containing treatment process wastes, that would otherwise be disposed of, and is instead converted to potable water in a treatment plant—the remainder is a reduced residual or solid waste stream. It is important for treatment processes in water-short areas to maximize the amount of a water supply that can be converted to potable water by reducing the amount that is discharged as a waste such as water used to backwash or clean the filtration system.

Public water systems in California use more than 17,000 groundwater wells and surface water supplies to meet the water supply needs of consumers. Some of these sources require treatment to either remove or inactivate contaminants or meet aesthetic quality prior to consumption. These could include minerals, metals, chemicals from industry or agriculture, pathogens and radiological constituents. Information on the number and type of water treatment plants installed on public water system sources in California is shown in Table 14-3.

PLACEHOLDER Table 14-3 Treatment Plants on California Public Water System Sources

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of the chapter.]

[**NOTE**: Table 14-3 to be updated, plan to include No. of WTPs that remove Perchlorate.]

Fluoridation

Fluoridation of community drinking water has been practiced in the United States for more than 65 years. It is accepted as a safe and effective public health practice for people of all ages. The previous five Surgeons General have recommended communities fluoridate their water to prevent tooth decay, the major form of preventable dental disease in America. California's fluoridated drinking water act, Assembly Bill 733, became law in 1995, requiring water systems with 10,000 or more service connections to fluoridate once money from an outside source is provided for both installation and operation and maintenance costs. CDPH is also responsible for identifying funds to purchase and install fluoridation equipment for public water systems.

During fluoridation treatment of public water system supplies, water systems adjust fluoride in drinking water to an optimal level shown to reduce the instances of tooth decay. Optimal fluoridation means that the water treatment facility and distribution system are closely managed to provide a consistent level of fluoride at the appropriate prophylactic level to reduce dental disease. Other water systems, through water purchase from wholesale provider that fluoridate, provide variable fluoridation at levels up to optimal level. The level of fluoride in these systems depends on many factors, including time of year, water demand, and the use of sources that may not have fluoridation treatment facilities. Information on the number of public water systems that are providing fluoridation in California is shown on Table 14-4.

PLACEHOLDER Table 14-4 Fluoridation in California

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of the chapter.]

[**NOTE**: Table 14-4 to be updated.]

Regulation

Both the USEPA and CDPH have ongoing programs for improving public health through new or more stringent drinking water regulations. These regulations include monitoring requirements, maximum contaminant levels (MCLs) in the water provided to the customer, multi-barrier treatment requirements, permitting requirements, public notification and more. These regulations include specific maximum contaminant levels (MCL) for constituents of health concern that are found to be present in drinking water sources. In California, new drinking water standards—the MCLs—are adopted only after development of a Public Health Goal (PHG), which is the level of a contaminant in drinking water below which there is no known or expected risk to health. PHGs are set by the California Environmental Protection Agency. MCLs take into account not only chemicals' health risks but also factors such as their detectability and treatability, as well as costs of treatment. California Health & Safety Code requires CDPH to establish a contaminant's MCL at a level as close to its PHG as is technically and economically feasible, placing primary emphasis on the protection of public health.

Where the adoption of a specific MCL is not practical, USEPA and CDPH have adopted specific treatment performance standards that essentially take the place of an MCL. An example of this is in the various rules for surface water treatment that are intended to provide protection against Giardia and Cryptosporidium, two microbial contaminants found in surface waters; where direct testing is impractical, costly or lacks the level of reliability necessary in setting an MCL.

In some cases, the State of California has adopted MCLs in advance of the federal adoption of an MCL. For example, in 2007, CDPH adopted a perchlorate MCL of 6 µg/L. This MCL is based primarily on potential adverse effects on the thyroid. In 2008, the USEPA indicated that it did not intend to adopt an MCL for perchlorate, however in 2011 the USEPA reversed its earlier decision and now plans to propose a formal rule for perchlorate (USEPA 2011).

An upcoming regulation is the State of California adoption of an MCL specific for hexavalent chromium. Currently, hexavalent chromium is regulated in drinking water through the establishment of a total chromium MCL (hexavalent chromium is one of the forms of chromium making up total chromium). In California, the total chromium MCL is 50 ppb, while the federal MCL is 100 ppb. At the time total chromium MCLs were established, ingested hexavalent chromium associated with consumption of drinking water was not considered to pose a cancer risk, as is now the case. CDPH is required by California law to adopt an MCL for hexavalent chromium and to set the MCL as close to the public health goal (PHG) as possible, taking into account technical feasibility (e.g., detectability and treatment) and costs. In 2011 the Office of Environmental Health Hazard Assessment (OEHHA) established a PHG of 0.02-ppb for hexavalent chromium, and CDPH is moving forward with the process of adopting an MCL for hexavalent chromium (CDPH 2012).

New Technology

New or innovative treatment technologies are often developed to address new or more stringent drinking water standards, to improve the efficiency of a contaminant removal, or simply to reduce either the treatment plant footprint, energy consumption or to reduce or eliminate waste streams from the treatment process. Innovative environmental technologies hold the promise of being more effective than traditional methods and able to address the far more complex environmental problems that we face today. Technologies increasingly used in California as a result of new regulations include:

- Ultraviolet (UV) disinfection treatment to comply with disinfection byproducts under the Stage 2 Disinfection Byproducts Rule and requirements for the treatment of surface waters under the Long Term 2 Enhanced Surface Water Treatment Rule.
- Arsenic removal technologies including adsorptive (disposable) media to increase affordability of small water system compliance with the arsenic MCL.

- Biological treatment in the form of fixed bed, fluidized bed and membrane bioreactors to treat for perchlorate, and now being demonstrated for nitrate and other contaminants.

As a result of both increases in demand and the relative scarcity of new water supplies, many water providers are now shifting toward the treatment of sources formerly considered unsuitable for domestic use. Treatment processes such as reverse osmosis are used to desalt brackish shallow groundwater for potable uses and are discussed in greater detail in the resource management strategy, Desalination. The relatively new technology of membrane filtration is now common for new surface water treatment plants.

Desalination

Proposition 50 included grant funding under Chapter 6 for demonstration of desalination and new treatment technologies. Funds are available to local agencies, water districts, academic and research institutions. The Proposition 50 desalination funds are being used for construction, pilot and demonstration projects, research and development, and feasibility studies to increase new water supplies using desalinization. The projects funded include desalination facilities in Marin, Alameda, Monterey, Ventura, and San Bernardino counties. Pilot projects in Long Beach, Santa Cruz, San Diego, and Los Angeles are among those that have received grants under the proposed funding plan. Research and development activities at the Lawrence Livermore National Laboratory and the University of California, Los Angeles, are included in the recommendations, as are feasibility studies by agencies in the Bay Area, Monterey, and Riverside County. Proposition 50 grant funding for demonstration of new treatment technologies includes the evaluation of tailored granular activated carbon in Redlands; concurrent removal of nitrate and Dibromochloropropane in the Central Valley; and removal of N-nitrosodimethylamine, endocrine disruptor chemicals, and pharmaceuticals and personal care products in South Delta Water; and a chromium 6 removal demonstration facility in Southern California.

New treatment technologies are often more energy-intensive than traditional water treatment processes, especially as we strive to reduce contaminants in treated drinking water. The Long Beach Water Department is undertaking a long-term study to evaluate the feasibility of desalination treatment with significantly lower energy consumption than typical reverse osmosis desalination.

[NOTE: Staff plan to revise the Desalination subsection with more recent information.]

Drinking Water Distribution in California

Water that is treated and/or conditioned to the point that it meets drinking water standards is considered to be “finished water”, suitable for distribution to consumers for all potable water uses. Water distribution systems consist of pipes, storage tanks, pumps and other physical features that deliver water from the source or water treatment plant to the customer’s connection. Even high quality drinking water is subject to degradation as it moves through the distribution system to the tap. For example, contaminants can enter the distribution system via backflow from a cross-connection, permeation and leaching, during water main repair or replacement, and contamination via finished water storage facilities. Within the distribution system, water quality may deteriorate as a result of microbial growth and biofilm, nitrification, corrosion, water age, effects of treatment on nutrient availability (contributing to microbial growth and biofilm), and sediments and scale within the distribution system (USEPA, 2006).

CDPH has established laws and regulations for the design, construction, operation and maintenance of distribution systems primarily through the California Waterworks Standards (CDPH, 2008a). Regulations mandate monitoring distribution system water quality for coliform bacteria, chlorine residual, lead, copper, physical water quality parameters, and disinfection byproducts. California also has adopted regulations for the control of cross-connections and backflow prevention within a water distribution system to protect the quality of the water.

In 2000, a federal advisory committee working on the development of more stringent USEPA regulations for disinfectant byproducts and microbial contamination noted the following as part of its key considerations on developing further regulations in these areas:

- Finished water storage and distribution systems may have an impact on water quality and may pose risks to public health.
- Cross-connections and backflow in distribution systems represent a significant public health risk.
- Water quality problems can be related to infrastructure problems and aging of distribution systems may increase risks of infrastructure problems.
- Distribution systems are highly complex and there is a significant need for additional information and analysis on the nature and magnitude of risk associated with them.

The maintenance of water quality within the distribution system has received considerable attention in recent years, especially as systems have modified methods of treatment. Changes to the methods and levels of disinfectants can create the potential for reduced control of microbial contaminants that may be present in the distribution system.

Water utilities are also constantly making improvements to their distribution systems, including increasing the reliability of their water supplies. One example is the installation of emergency water interties between neighboring water utilities. These provide a backup source (the neighboring water system) in the case of an outage due either to some unforeseen emergency or potential disaster, and also allow a water utility to shut down a part of its system to do necessary maintenance without interrupting service to customers.

For example, there is an emergency intertie between the East Bay Municipal Utility District, City of Hayward, and the San Francisco Public Utilities Commission (SFPUC) to supply treated water between the three water systems and is intended to be used during planned outages for needed maintenance and to avoid service interruptions. EBMUD has two small interties, each able to carry 4 million gallons per day, with the City of Hayward, which adjoins its service area. SFPUC, which is the agency in charge of the Hetch Hetchy water used by many Bay Area water districts and residents, constructed an intertie with the Santa Clara Valley Water Agency and has been considering another. These interties may also play a role in the security of the water distribution system by creating a backup source should a terrorist action or disaster disrupt the source of supply from a single water provider.

In other cases, interties can provide untreated water between utilities to provide untreated source water in an emergency. For example, Contra Costa Water District (CCWD), whose service area is crossed by EBMUD Mokelumne pipeline, has an intertie which can be used to transfer untreated water between EBMUD and CCWD in an emergency.

Interties are one of the strategies for improving water supply reliability and quality which were recommended by the CALFED August 28, 2000, Record of Decision.

Potential Benefits of Drinking Water Treatment and Distribution

Improved water quality can directly improve the health of Californians, thereby improving the state's standard of living and reducing the burden and costs on the state's healthcare system.

[NOTE: Content to be developed on benefits of removing pathogens.]

The perchlorate MCL and the arsenic MCL reduce the permissible level of these contaminants and result in direct benefits. Perchlorate exposure is of public health concern because it interferes with the ability of the thyroid gland to produce hormones. In the very young, hormones are needed for normal prenatal and postnatal growth and development, particularly normal brain development. Therefore, a reduction of thyroid hormones is a serious concern. In adults, thyroid hormones are needed for normal body metabolism. About 515,000 people in California will avoid exposure to perchlorate at levels above the MCL annually as a direct result of the perchlorate regulation (CDPH, 2007). The arsenic MCL of 10 µg/L will result in a reduction in exposure for more than 790,000 people and a theoretical reduction of 57 lung and bladder cancer cases per year in California (CDPH, 2004).

Adequate operation and maintenance of the distribution system network will reduce delivery problems (main or tank ruptures, water outages) and ensure delivery of high quality water. In California, operators of drinking water distribution systems must be certified at the appropriate level depending on the size and complexity of the distribution system. This requirement for certification helps to ensure a competent level of operation of distribution systems.

Similarly for water treatment facilities, proper operation and maintenance is essential for achieving optimum water treatment plant performance. In California, operators of drinking water treatment facilities must be certified at the appropriate level depending on the size and complexity of the treatment facilities.

Water fluoridation ranks as one of ten great public health achievements of the 20th century according to the Surgeon General in 2000. Fluoridation of public water supplies targets the group which would benefit the most from its addition, namely infants and young children under the age of 12, decreasing cavities and improving dental health. Studies have shown unequivocally that fluoridation, at the optimal concentration, reduces the incidence of dental caries by 50-70 percent. It has also been demonstrated that caries will increase if water fluoridation is discontinued in a community for an extended period. One example is in Antigo, Wisconsin. Antigo started fluoridating its community water supplies in 1949 and discontinued it in 1960. Five and one-half years later, second graders had more than 200 percent more decay, fourth graders had 70 percent more, and sixth graders had 91 percent more decay than those of the same age in 1960 (CDPH Community Water Fluoridation Program).

Potential Costs of Drinking Water Treatment and Distribution

The cost of providing drinking water in compliance with all drinking water standards is steadily increasing due to increasing costs for energy and materials and increasing regulations requiring higher levels of treatment. Water bills reflect the costs of pumping, treating and delivery of water, as well as the operation and maintenance of the system, water quality testing and debt repayment. Water treatment costs may include the cost of chemicals, energy, and operation and maintenance of the treatment facilities. Drinking water treatment costs will vary widely from plant to plant. Many different factors can affect the cost of water treatment, including the choice of which water treatment technology to use.

Table 14-5 summarizes the past and future estimated costs of treated full service water provided by the Metropolitan Water District of Southern California (MWD), which treats a blend of surface water from the Colorado River and the California Aqueduct. This shows an increase of approximately 65% (from 2007 to 2012) in the cost of providing treated water in an area serving a large rate base. The additional cost reflects improvements to the treatment provided, increased cost for chemicals and energy, and reduced availability of new water supplies. The primary cost factors causing the rate increase included increased conservation efforts, the quagga mussel control program, litigation and the higher cost for State Water Project deliveries. MWD may not capture the true cost of service with these rates, and must cover some costs through the use of reserves.

PLACEHOLDER Table 14-5 Metropolitan Water District of Southern California Treated Water Rate History

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of the chapter.]

The increase in cost to provide safe drinking water for small water systems may be significantly greater, and they will not have reserves to offset rate increases. Per household costs for compliance with new regulations for small water systems can be over four-fold higher than those for medium to large water systems (Fed Regist., 2006).

Trends of increasing water rates and connection fees can be partially attributed to aging infrastructure and rising construction costs. In the 2011 California-Nevada Water Rater Survey conducted by the California-Nevada Section of the American Water Works Association, the survey results revealed that the average residential monthly charge for 1,500 cubic feet (11,000 gallons) of water a month increased in 3 of the 4 regions from 2009 to 2011. The San Joaquin Valley region showed a decrease that was attributed to utilities in the region switching from flat rate to variable rate billing which resulted in customers who use 1,500 cf of water receiving a reduced bill (CA-NV AWWA 2012). The survey results for California by region for 2009 and 2011 are shown in Table 14-6. This shows that the central coast communities continue to have the highest average residential monthly water charge, while the San Joaquin Valley continues to have the lowest average residential monthly water charge.

PLACEHOLDER Table 14-6 Monthly Average Water Charges in California by Region

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of the chapter.]

Treatment costs for compliance with the arsenic MCL in California affects more than one million households in about 275 water systems. The average annualized cost per household to comply with the arsenic MCL is estimated to range from $140 to $1,870 depending on the size of the water system (CDPH, 2008b). These treatment costs are in addition to current costs for drinking water.

Up to one-third of the operations and maintenance costs for some water utilities are energy related, including energy used for water treatment and pumping. One factor in water-related energy consumption is the use of new technologies that are more energy intensive than most previous treatment technologies—UV treatment and high pressure membranes for example.

Desalination will play an increasing role in water supply in California, both for brackish groundwater desalination and seawater desalination. Historically, the high cost and energy requirements of desalination had confined its use to places where energy is inexpensive and freshwater scarce. Recent advances in technology, especially improvements in membranes, have made desalination a realistic water supply option. The cost of desalinating seawater is now competitive with other alternatives in some locations and for some high-valued uses. However, although process costs have been reduced due to the newer membranes that allow for lower energy consumption, the total costs of desalination, including the costs of planning, permitting and waste salt concentrate management, remain relatively high, both in absolute terms and in comparison with the costs of other alternatives (National Resource Council, 2008). Since development of other traditional sources of supply in California is limited and may require substantial capital investment to develop (such as new storage or canal systems), the expanded development of brackish water and seawater desalination may become more cost-competitive.

The condition of infrastructure is a growing concern in California and throughout the country. In its "Report Card for America's Infrastructure", the American Society of Civil Engineers gave water infrastructure across the country a D-minus. The USEPA has conducted a Drinking Water Infrastructure Needs Survey and Assessment in 1995, 1999, 2003 and most recently in 2007. The 2007 survey shows a total investment need of $334.8 billion over the next 20 years nationwide. For California, it identified a total need of $39.0 billion. This is more than 10 percent of the national need. The majority of this need is for transmission and distribution systems. This estimate does not include the infrastructure needs for Tribes, documented at $721 million over the three-state area of California, Nevada, and Arizona (USEPA, 2009). This cost does not include the costs for treatment of new water supplies needed to offset losses in water resources from the Colorado River and the State Water Project, nor current drought conditions.

[NOTE: The above paragraph to be updated with the 2011 Needs Survey if it is available prior to the release of the final draft.]

Funding for drinking water projects on Tribal lands is provided by the federal government as part of the Drinking Water Infrastructure Grants: Tribal Set-aside Program, which was established by the federal Safe Drinking Water Act reauthorization of 1996. The program allows the USEPA to award federal grants for infrastructure improvements for public drinking water systems that serve Tribes.

Major Issues Facing Drinking Water Treatment and Distribution

Based on a review of issues discussed within the water supply industry and regulatory agencies, the following represent some of the most significant challenges facing public water suppliers and the regulatory agencies today.

Deteriorating Infrastructure

With the aging of the nation's infrastructure and the growing investment needed to replace deteriorated facilities, the water industry faces a significant challenge to sustain and advance its achievements in protecting public health and the environment (Grumbles, 2007). Over the last several decades, the public investment has been toward expanding and upgrading service levels, such as providing higher levels of treatment. At the same time, our urban areas have expanded with a reduced density of urban population. This means we are living farther away from the central hub of the community. This requires more investment in water and wastewater facilities for the same number of people. Both of these issues—higher treatment levels and expanded service areas—result in less available funds to maintain the present infrastructure.

New solutions are needed for critical drinking water investments over the next two decades. Not meeting the investment needs of the next 20 years risks reversing the public health, environmental, and economic gains made within our communities. Water utilities are moving to the concept of asset management to better manage and maintain their water facilities and infrastructure (Cromwell et al., 2007) for greater operational efficiency and effective use of limited funds. However, addressing infrastructure will add to the cost of water.

Asset management alone will not fix the basic problem. Current water rates in the majority of water systems are typically not adequate to address new regulatory requirements as well as maintain the existing facilities, and often do not generate adequate reserves to address infrastructure replacement. Water supplies may be undervalued based on the typical water rate paid by consumers versus the great role water plays in the health and well-being of our communities. However, with increasing costs for food, fuel, and energy, additional increases in the cost of receiving potable water may be a serious problem for many residents, especially those on fixed income.

CDPH also has set aside funding from the DWSRF program to provide technical assistance to small water system operators and managers on technical, managerial, and financial areas. Additional funding in this area would allow the expansion of this program into more detailed areas of asset management and rate setting.

Source Water Protection

There is an increasing need to protect source water quality as the first critical barrier in the multiple barrier approach to providing safe drinking water. A key issue is the increasing difficulty of protecting source water quality as the population of the state increases resulting in increased discharge of wastewater and urban runoff into surface water supplies. Another major issue is that some drinking water contaminants (organic carbon, nutrients, pathogens such as Giardia and Cryptosporidium) are not currently regulated by the Regional Boards in Basin Plans. Thus, there are generally not requirements for dischargers to control these contaminants.

Inadequate Financial Assistance to Address Both Water Treatment and Infrastructure Issues of Public Water Systems

Three major funding programs for California public water systems include DWSRF, Proposition 50, and Proposition 84. Combined, these programs have provided $970 million to 200 public water systems to solve health risk problems and Safe Drinking Water Act violations, resulting in an overall reduction in risk for consumers. However, this funding has not been adequate to address all of the needs identified in California. The combined project priority list for these three funding programs includes more than 4,000 projects, many of which have been on the list since its inception in 1997. The estimated value of unfunded need on the combined project priority list exceeds $8.2 billion.

Likewise, California has seen a reduction in the federal annual capitalization grants that fund the DWSRF program (see Table 14-7). This reduction resulted from inadequate estimate of infrastructure needs in California under the 2003 Needs Survey. CDPH is working on the 2007 Needs Survey to accurately identify infrastructure funding requirements for California drinking water systems. Funding from Proposition 50, which also has a portion targeted to disadvantaged communities, will likely be fully committed by 2009.

PLACEHOLDER Table 14-7 California Drinking Water State Revolving Fund: Capitalization Grants from the U.S. EPA

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of the chapter.]

(**NOTE**: Table 14-7 to be updated.)

For water systems that received either low interest loans through the DWSRF program or grants through Propositions 50 and 84, these funds are used to design and build the project. The funds are not used for ongoing operation and maintenance of the water project. Water utilities must pay for the operation and maintenance costs, which can be significant, through water rates or other revenues.

[NOTE: The above subsection to be updated with more recent funding information. Table 14-7 to be updated.]

Regionalization/Consolidation

One way to improve the economy of scale (resulting in the potential for many benefits including lower costs) is to increase regionalization of water supply systems. This can be achieved by physical interconnections between water systems or managerial coordination among utilities. CDPH has established a requirement for consolidation to be evaluated as part of every project funded under the available financial assistance programs. To successfully address deteriorating infrastructure for the hundreds of smaller public water systems in California, regionalization and consolidation may be necessary on a larger scale. It is not cost effective for a small system to fully replace aging and deteriorated sources, treatment plants, and distribution systems. However, with a larger rate base to spread costs across, the economies of scale improve for consolidated systems. Managerial consolidation of water districts, even where the boundaries are not contiguous, can provide great savings to the consumers by sharing the costs of oversight and management of the systems, thus freeing up funds to be used for system upgrades.

[NOTE: Possibly include a Case Study of a recent successful consolidation project.]

Disadvantaged Communities/Environmental Justice

Interest in environmental justice issues has heightened as a result of nitrate contamination problems in public water systems, particularly those in agricultural areas such as the Central Valley. It is the role of the federal government to ensure that, in the development and implementation of new regulations, disadvantaged communities are protected at levels afforded to other demographic communities. Presidential Executive Order 12898 establishes a federal policy for incorporating environmental justice into federal agencies' missions by directing agencies to identify and address disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations.

Each of the three major water system funding programs implemented by CDPH provides some special financing for water systems that serve disadvantaged communities (DAC). Communities are considered disadvantaged if the median household income (MHI) is 80 percent or less than the statewide MHI. For example, the DWSRF can provide grant funds and zero-interest loans to water systems serving a DAC. Proposition 50 funding has a target goal of 25 percent of the funding to be provided to DACs. A significant portion of the Proposition 84 funds allocated to drinking water are specifically targeted at small disadvantaged communities with contamination problems. Funding from both Propositions 50 and 84 is limited due to the one-time allocation specified for drinking water.

Impact of Climate Change

[Note: This section has been updated. The updated text is shown at the end of this PDF.]

~~The impact of climate change on water quality has been estimated scientifically (Cromwell et al., 2007; IPCC, 2007). Earlier snowmelt, changes in normal seasonal timing of run-off and more intense episodes of precipitation will likely increase turbidity in source waters. Increased flooding may lead to sewage overflows, resulting in higher pathogen loading in the source waters. Changes to seasonal flows, may increase water temperatures and shallower reservoirs may result in more prevalent eutrophic conditions in storage reservoirs, increasing the frequency and locations of cyanobacterial blooms. These potential changes could result in challenges for surface water treatment plants and require additional monitoring to quantify changes in source water quality and better control of finished water quality. Higher sea levels could impact coastal groundwater basins making the protection of groundwater from seawater intrusion more difficult (CUWA, 2007).~~

~~Increasing demand on the limited valuable water resources available in California will compound any impact from climate change. The continued growth in the state will continue to stress the availability of the freshwater resources needed for domestic, agricultural, and industrial uses. California coastal water providers have begun evaluating the feasibility of desalination of seawater as an additional supply. Desalinated seawater, although more expensive to develop due to the high energy requirements and planning and permitting costs, has been identified as a reliable drought-proof supply.~~

~~As highlighted earlier, Proposition 50 funding of desalination construction and demonstration projects is a critical resource to drive evaluation and implementation of desalination technologies in California.~~

Efficient Use of Water

The efficient use of water is seen as a viable complement to—and in some instances, a substitute for—investments in long-term water supplies and infrastructure. Water use efficiency is a concept to maximize the use of water or to minimize its waste. Water use efficiency will continue to be a key element of addressing reduced water availability and is seen as a major step to be addressed before turning to more costly water sources such as desalinated seawater. Water efficiency programs and practices may include utility leak detection, water conservation programs, water efficiency pricing and incentives for installing water efficient appliances and landscaping, as well as improvements in water recovery as part of water treatment plants (reducing water used in treatment plant processes for backwash, etc.).

An important aspect of strongly encouraging water conservation is the ability of the water utility to establish an escalating metered rate based on the volume of water used—promoting full cost recovery, conservation or efficiency pricing. Since 1992, California law has required urban water suppliers (those serving more than 3,000 connections or delivering more than 3,000 AF of water per year) to install a water meter on new connections. More recently, AB 2572 established the requirement for retrofitting water meters on pre-existing connections and charging customers for water based on the actual volume of water used. Neither of these laws addresses smaller water systems that do not meet the definition of an urban water supplier.

However, many larger water agencies have already taken advantage of conservation programs to reduce the need for new water supplies. The Los Angeles Department of Water and Power (LADWP) has shown success in conservation where water use today is the same as it was 25 years ago, despite an increase in population of nearly 1 million people (LADWP, 2007). Obtaining additional increases in conservation will be more difficult and may result in higher costs to achieve.

To address water losses, or unaccounted for water, water utilities are conducting audits to identify water main leaks, unmetered water use for parks and recreation consumption, water theft and inaccurate meters. Deteriorated and aging infrastructure can play an important role in water losses, contributing to significant water leakage and a high rate of main breaks. And with the continued aging of distribution infrastructure, that is at or near the end of its useful life, water losses due to water main leaks can be expected to remain a significant and potentially growing barrier in California's efforts to conserve water.

Maintaining a Trained Workforce

The State of California requires that operators of water treatment plants and distribution systems receive certification to perform these duties. This certification is designed to ensure that operators have adequate knowledge, experience, and training to properly operate these facilities. In view of the increased complexity of water system facilities, the importance of properly trained and certified operators is increasing.

Sustaining a trained workforce to maintain an adequate level of qualified oversight at water treatment plants and operation of distribution systems has been identified as an important issue. This is in part a result of the increased number of people from the large Baby Boomer generation beginning to leave the workforce. CDPH data indicate that the average age of operators certified in California is about 50 years, while Grade 5 treatment plant operators (the highest treatment certification available) is greater than 55 years of age (Jordan, 2006). Many water utilities will lose 30 to 50 percent of their current workforce within the next 5 to 7 years, which will result in an unprecedented knowledge drain. A knowledge-retention strategy is necessary to ensure long-term success.

Knowledge-retention, broadly termed “succession planning,” is the process of identifying and preparing suitable employees through mentoring, training, and job rotation, to replace key players—such as treatment or utility managers—within an organization as their current managers retire. Succession planning will grow in importance in the near future to ensure the transfer of knowledge as less experienced staff moves into higher decision-making positions. This issue applies to both the public and private water sector, as well as the government agencies in place to regulate the water industry. Graduating engineering students show a noticeable lack of interest in the water industry.

Through a grant provided by USEPA, CDPH introduced in November 2006 the Expense Reimbursement Grant Program for small water system operators. This program provided funding for small water system operators to receive reimbursement for training taken to maintain and advance their operator certification levels. Unfortunately, all the funding for this program was recently expended and reimbursement for trainings are currently unavailable.

Treatment Technologies for Small Water Systems

Providing safe and affordable drinking water is still a significant challenge for small water systems. Economies of scale typically become more limited for the small system size categories, resulting in per-household costs for compliance with new regulations that can be over four-fold higher than those for medium to large water systems (Fed Regist., 2006). Advances have been made in the effective use of point-of-use (POU) and point-of-entry (POE) technologies for certain contaminants under controlled circumstances for some small drinking water systems (Cadmus Group, 2006). POU devices are those that treat water at the location it is to be consumed, such as at the tap or a drinking fountain. POE devices are those that treat all of the water entering a home or building, not just that which is consumed. POE technologies would treat all water that a consumer comes in contact with, such as through bathing and hand washing, while a POU will only provide treated water at one tap intended for drinking and cooking (usually installed in the kitchen). The California SDWA allows the consideration and approval of POU and POE devices for compliance with drinking water standards where amongst other requirements it can be demonstrated that centralized treatment (at the well head or surface water intake) is not economically feasible.

New treatment technologies are often needed to address chemical contaminants that affect small water systems - technologies that can be cost-effective and do not require extensive operator attention. Proposition 50 has provided funding for demonstration of some of these types of technologies. As new technologies are proposed to treat water to drinking water standards, CDPH must review and approve these technologies, using staff dedicated to these technical aspects of drinking water treatment reviews.

Treatment Residuals Disposal

In many areas, treatment options for contaminants are limited due to residual disposal issues. For example, the disposal of brine from ion exchange and reverse osmosis treatment is being identified as a potential source of salinity in groundwater. California, and especially the central San Joaquin Valley, is experiencing increasing salts in the groundwater water. As the salinity of local groundwater sources increase, more water customers use water softeners to improve the quality at their tap. This in turn results in a higher discharge of salts to the wastewater treatment plants, increasing the salinity of wastewater and exacerbating the problem. The Central Valley Regional Water Quality Control Board completed a study in May 2006 on salinity in groundwater in the Central Valley, introducing the concept of a long-term salinity management program for the Central Valley and the State of California (CVRWQCB, 2006).

Disposal of residuals such as backwash water or spent media poses additional costs for water treatment, especially those that may be classified as a hazardous or radioactive waste due to the concentration and leaching characteristics of the contaminant. Selection of treatment alternatives for arsenic, especially, must consider disposal issues. The spent treatment plant media must be evaluated under the California Waste Extraction Test (WET) for classification prior to determining appropriate disposal options due to the potential for the arsenic to leach off the media in a landfill environment. The California WET classification is more stringent than federal leaching tests.

Security of Drinking Water Facilities

Water system facilities are vulnerable to security breaches, intentional acts of terrorism, and natural disasters. Both water system personnel and the general public have developed a greater awareness of this vulnerability of our infrastructure as a result of the events of September 11, 2001, and Hurricane Katrina in 2005. The enhancement of security and emergency response capability are crucial in maintaining a reliable supply and delivery of drinking water.

Under the US Public Health Security and Bioterrorism Preparedness and Response Act of 2002, drinking water utilities serving more than 3,300 people are required to conduct Vulnerability Assessments and develop Emergency Response Plans. All of California's water utilities in this category prepared these documents. These documents are an important element in building and maintaining the ability to respond to security breaches and other catastrophes.

Accomplishments to protect our water and wastewater facilities from terrorism by the water and wastewater industry and regulatory agencies include the following:

- Emergency Water Quality Sample Kit developed by CDPH, based on the USEPA Response Protocol Toolbox, to quickly provide water systems with a resource to sample drinking water for an unknown contaminant during a credible event.
- Partnerships between water agencies and the regulatory community established to address emergency response, including the California Water/Wastewater Agency Response Network (WARN); Laboratory Response Network (LRN); and the California Mutual Aid Laboratory Network (CAMAL Net).
- Water Infrastructure Security Enhancement (WISE) Guidelines drafted for the Physical Security of Water/Wastewater Utilities by national water and wastewater organizations. It provides recommendations for the management, operation, construction, and retrofit of water and wastewater treatment plants and distribution/collection systems to enhance physical security. The WISE Guidelines can be found at the following Web page: http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Security.aspx

WARN systems facilitate a utilities-helping-utilities approach to providing assistance during times of crisis. By establishing mutual aid agreements before a crisis occurs, WARN participants pave the way for member utilities within (and outside) of their respective states to send valuable aid in a quick and efficient manner. WARN participants can access specialized resources to assess and assist water and wastewater systems until such time as the system can develop a permanent operating solution.

Existing and Emerging Contaminants

New contaminants in drinking water are often discovered and then regulated because of increased pollution, improved analytical abilities, and/or understanding of health effects. Media attention to a particular contaminant has also resulted in a legislative response to address or speed up the regulatory process. Examples of these include hexavalent chromium (Chrome-6) and pharmaceuticals and personal care products. In addition, the health effects of many known contaminants are re-evaluated, and reregulated, in light of new information. For many emerging contaminants, such as pharmaceuticals and personal care products, there may not yet be a full understanding of the health risks and available treatment technologies to remove them from drinking water. For such contaminants, the pollution prevention and matching water quality to water use resource strategies will help address water quality concerns while additional information is gathered. For pharmaceuticals and personal care products, control of discharge to the environment is the best initial approach (via source control programs and reduction through wastewater treatment) rather than relying on treatment of drinking water.

Emerging contaminants may be created by treatment itself, for instance, when water utilities implement new methods or processes for disinfecting water that may create new disinfection byproducts. For some contaminants, treatment options may be available, but may be relatively expensive.

Recommendations

Because of the importance of drinking water, there is strong interest from many groups to promote improvements to the drinking water treatment and distribution facilities, operation, and management. These groups include:

- Water system managers and operators
- Local governmental agencies—city, county, planning
- Regulatory agencies such as CDPH, local primacy agencies (county-level) and USEPA
- Environmental and community stakeholders

Based on the major issues outlined in this chapter, the following additional actions are needed to ensure there is adequate protection of public health through the maintenance of infrastructure, advancements in water treatment, and developing and maintaining relationships among the groups that advocate for safe drinking water:

1. The Legislature should take steps necessary to develop a more sustainable source of funding of water supply, water treatment, and infrastructure projects to ensure a safe and reliable supply of drinking water for individuals and communities.
2. Additional funding should be provided to CDPH to provide increased technical assistance to small water systems related to asset management and rate setting.
3. The legislature should take steps to assure that publicly owned water systems set water rates at a level necessary: to provide safe water; replace critical infrastructure, repay financing for treatment necessary to meet drinking water standards or needed infrastructure improvement and/or replacement; and that are at a level that assure the sustainability of the water system for future generations of Californians.

4. State government should support enactment of a federal water infrastructure trust fund act that would provide a reliable source of federal assistance for the construction and repair of water treatment plants.
5. Additional programs should be developed to encourage regionalization and consolidation of public water systems. Regionalization and consolidation are useful both in achieving compliance with water quality standards and in providing an adequate economy of scale for operating and maintaining existing facilities as well as planning for future needs.
6. State government should continue to develop funding for small water systems and disadvantaged communities to assist in complying with drinking water standards.
7. State government should continue to encourage conservation and develop additional incentives, such as expanded rebate programs, to allow water systems to reduce the waste of limited water resources.
8. Public water systems that provide flat rate water service should strongly consider moving to a metered water rate structure to discourage waste. In addition, water systems that do have water meters on some customers but not all connections should strongly consider providing water meters for all customers.
9. State government should consider providing incentives that would encourage water systems to adopt rate structures that encourage conservation and discourage the waste of water.
10. The Legislature should establish a requirement for all public water systems (whether in urban areas or other areas of the state) to install a meter on each service connection and charge a metered rate for actual volume of water used.
11. California's regulatory agencies, such as the State Water Resources Control Board and California Department of Public Health, should be able to maintain internship programs for college students to continue the interest of the next generation in the water and environmental regulatory agencies.
12. State government should support research and development of new treatment technologies through expansion of the funding provided through Proposition 50 for demonstration of new treatment technologies. Additional program funding is also needed by CDPH to adequately address the review and acceptance of these new treatment technologies.
13. In view of the increased costs and other issues associated with disposal of residual wastes, water systems should fully evaluate residual disposal issues in the planning of new water treatment facilities.
14. All public water systems should be encouraged to join the California WARN program. This program will be able to provide mutual aid and assistance more quickly than the normal resource requests through SEMS. CDPH will encourage this recommendation as part of security training and emergency response exercises conducted with water utilities.
15. The control of pharmaceuticals and personal care products in our environment should be addressed initially via source control programs and reduction through wastewater treatment.

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Additional References

Personal Communications

Table 14-1 Public Water Systems in California by Class

Public water system classification	Number
Community	3,036
Nontransient noncommunity	1,505
Transient noncommunity	3,176
Total number of public water systems	7,717

Note: Based on CDPH records March 2012. Does not include water systems serving Native American Tribes.

Table 14-2 Number and Type of CPUC-Regulated Water Agencies

CPUC class	Number of connections served	Number of agencies in class
A	>10,000	10 [a]
B	2,000-10,000	6 [a]
C	500-2,000	22
D	<500	85

Source: CPUC website June 2012.

[a] Many of the private agencies included in the number shown operate multiple water systems throughout California

Table 14-3 Treatment Plants on California Public Water System Sources

Type of contaminant	Number of treatment plants
Surface water [a]	660
Nitrate	150 [b]
Arsenic	65 [b]
Radiological	15 [b]
Volatile and synthetic organic chemicals	220 [b]
Aesthetic water quality	350

Source: These estimates are based on a survey of CDPH offices and from CDPH records.

[a] Surface water, as defined under the California Surface Water Treatment Rule (Cal. Code Regs., tit. 22, § 64651.83.) means "all water open to the atmosphere and subject to surface runoff..." and hence would include all lakes, rivers, streams and other water bodies. Surface water thus includes all groundwater sources that are deemed to be under the influence of surface water (i.e., springs, shallow wells, wells close to rivers), which must comply with the same level of treatment as surface water.

[b] Includes chemical removal and blending treatment facilities

NOTE: Table to be updated. Plan to include the No. of WTPs that remove Perchlorate.

Table 14-4 Fluoridation in California

Public water systems providing fluoridation	Number of systems	Population served (millions)
Public water systems providing optimal fluoridation		
Systems adding fluoride to the optimal level	54	9.5
Systems receiving fluoridated water at the optimal level	73	3.0
Total systems implementing optimal fluoridation	127	12.5
Public water systems providing variable fluoridation		
Systems providing fluoridated water at variable levels	136	9.3

Source: California Department of Public Health 2009.

NOTE: Table to be updated.

Table 14-5 Metropolitan Water District of Southern California Treated Water Rate History

Year	Cost of treated water ($/AF)	
Historical and current water rates		
1994	412	
1995-1996	426	
1997-2002	431	
	Tier 1 [a]	**Tier 2 [b]**
2003	408	489
2004	418	499
2005	443	524
2006	453	549
2007	478	574
2008	508	606
2009	579	695
2010	701	811
2011	744	869
2012	794	920
Projected future water rates		
2013	847	997
2014	890	1032

Source: Metropolitan Water District of Southern California 2012.

[a] Tier 1 supply rate – recovers the cost of maintaining a reliable amount of supply.

[b] Tier 2 supply rate – set at Metropolitan Water District cost of developing additional supply and to encourage efficient use of local resources.

Table 14-6 Monthly Average Water Charges in California by Region

Region	2009	2011
Northern	$51.15	$58.07
Central Coast	$52.14	$68.16
San Joaquin Valley	$34.42	$29.30
Southern	$44.24	$52.39

Source: California-Nevada Section, American Water Works Association 2011.

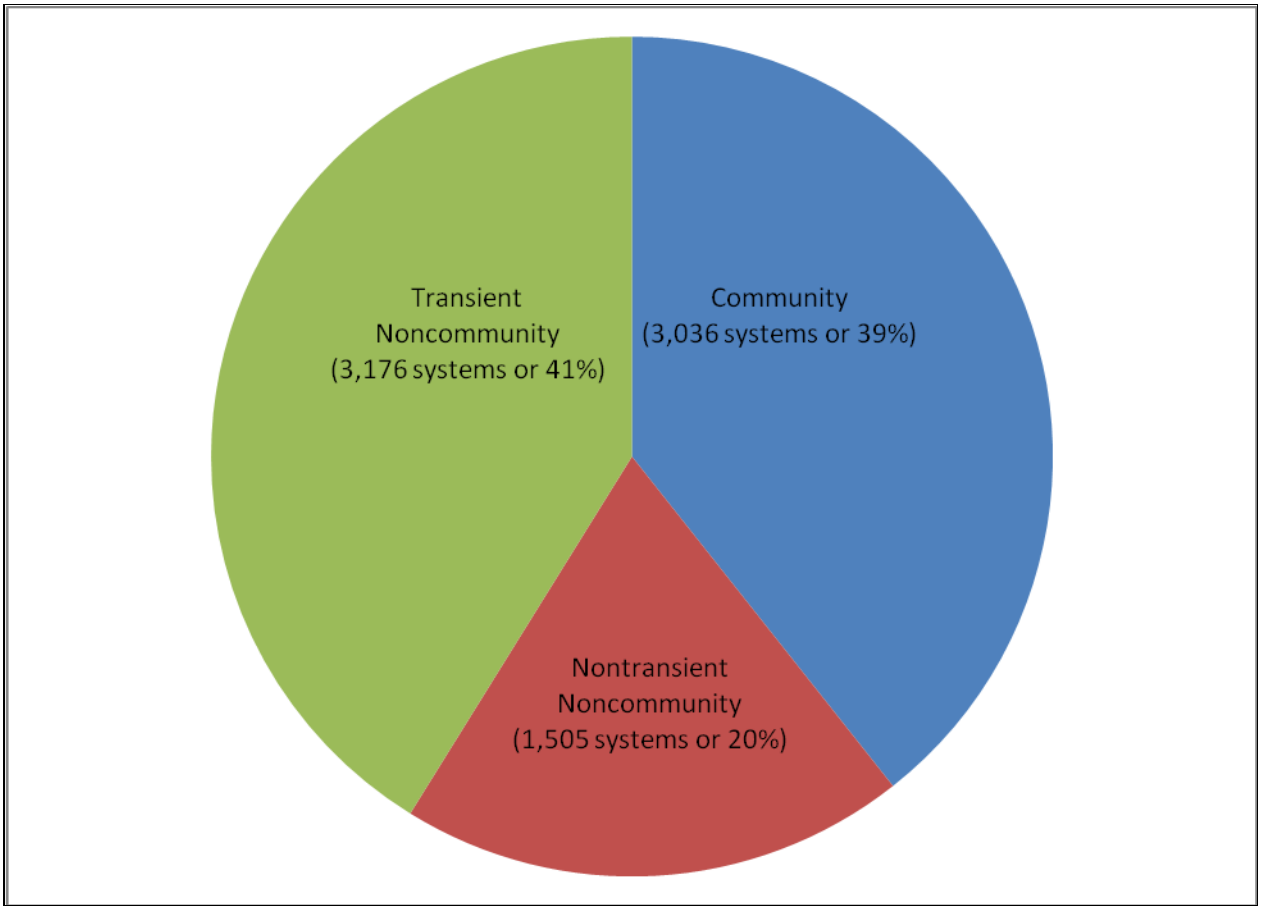
Table 14-7 California Drinking Water State Revolving Fund: Capitalization Grants from the U.S. EPA

Fiscal year	DWSRF grant (million $)	% of national funds
1997	75.68	—
1998	77.11	10.83% (FY1998-2001)
1999	80.82	—
2000	83.99	—
2001	84.34	—
2002	82.46	10.24% (FY2002-2005)
2003	81.97	—
2004	85.03	—
2005	84.85	—
2006	67.10	8.15% (FY2006-2009)
2007	67.10	—

Source: U.S. EPA Drinking Water Needs Survey 2009.

NOTE: Table to be updated.

Figure 14-1 Public Water System Class by Size and Percent



Updated Climate Change Text

Climate change projections include warmer air temperatures, diminishing snowpack, precipitation extremes and storm intensity, prolonged droughts, and sea level rise. These anticipated changes could affect water quality in regions that are already experiencing difficulty meeting current water demands.

Earlier snowmelt and more intense episodes of precipitation with increased flood peaks may lead to more erosion, resulting in increased turbidity and concentrated pulses of pollutants in source waters. Increased flooding may lead to sewage overflows, resulting in higher pathogen loading in source waters. These potential changes could result in challenges for surface water treatment plants and may require additional monitoring to quantify changes in source water quality and to meet post-treatment drinking water standards.

Increased water temperatures and reduced reservoir levels may result in more prevalent eutrophic conditions, increasing the frequency and duration of algal blooms. Higher water temperatures can also accelerate some biological and chemical processes, increasing growth of algae and microorganisms, the depletion of dissolved oxygen, and various impacts to water treatment processes. Higher sea levels as a result of climate change could impact coastal groundwater basins making protection of groundwater from seawater intrusion more difficult.

Adaptation

Increasing demand on the limited valuable water resources available in California will compound any impact from climate change. The continued growth in the state will continue to stress the availability of the freshwater resources needed for domestic, agricultural, and industrial uses. California coastal water providers have begun evaluating and employing desalination of seawater as an additional drinking water supply. Desalinated seawater, although more expensive to develop due to the high energy requirements and planning and permitting costs, has been identified as a reliable drought-proof supply.

Regionalization of water supply systems as an adaptation strategy will also help counter the effects of climate change by adding distribution flexibility during periods of drought or flooding. Investments in drinking water facilities and conveyance systems will add efficiency and lead to enhanced sustainability in the future. Adaptation to climate change to provide adequate drinking water will likely require specific regional strategies outlined in this chapter focused on conservation, sustainability, and operational flexibility.

Mitigation

Demand for drinking water treatment and distribution will continue to increase as climate change has major impacts on water quality and availability of the freshwater resources for drinking water uses. Adverse impacts on climate change related to increasing Greenhouse Gases Emissions could result from energy uses in 1) drinking water treatment and distribution systems, 2) bottled water production and related transportation and waste disposal, 3) new sources of drinking water from desalination, low quality groundwater, and reuse wastewater. However, improving water and energy efficiency from management strategies in this chapter could have benefits to reduce energy uses and green house gas emissions for climate change mitigation, including the following:

- Promote opportunities to use more tap water and less bottled water to reduce related energy and

GHG emissions;

- Conduct audits for water and energy efficiency in drinking water treatment and distribution systems;
- Provide operational efficiency and improve aging infrastructure to control water losses for water and energy saving;
- Develop programs and apply new technologies to reduce energy use in both water treatment plants and for new sources of drinking water from desalination, low quality groundwater, and reuse wastewater;
- Develop energy efficiency standards for drinking water treatment and distribution systems;
- Coordinate with water use efficiency programs and use best management practices to save water and energy, including utility leak detection, water conservation, and water efficiency pricing and incentives for installing water efficient appliances and landscaping.